

forming a refractory metal second layer over the refractory metal first layer;  
forming a refractory metal third layer above and on the refractory metal second layer, wherein the [third] refractory metal third layer is substantially the same metal as the refractory metal first layer;  
forming a refractory metal fourth layer above and on the refractory metal third layer, wherein the refractory metal fourth layer is substantially the same metal as the refractory metal second layer; and  
forming an electrically connective bump above the refractory metal fourth layer.

#### **REMARKS**

Applicant has carefully reviewed and considered the Office Action mailed on November 1, 2002, and the references cited therewith.

Claims 17 is amended; as a result, claims 17-19, 21, 23, and 25 are now pending as an elected species in this application. Claim 17 was reworded to make phrasing consistent with earlier claim language in claim 17, regarding the refractory metal third layer. No new matter was added by this amendment.

#### **Rejections Under 35 U.S.C. §103**

Claims 17, 19, 21, 23, and 25 were rejected under 35 U.S.C. §103(a) as being unpatentable over Agarwala et al. (U.S. Patent No. 5,376,584) in view of Yi et al. (U.S. Patent No. 6,348,730 B1). Applicant respectfully traverses the rejection and requests the Office to consider the following.

To establish a prima facie case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim

limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. In re Vaeck, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991). (M.P.E.P. § 2143 8<sup>th</sup> Ed).

Initially, the Office Action admits that Agarwala '584 does not indicate that the metal layers include "first and third layers of substantially the same metal and the second and fourth metals of substantially the same metal." (Office Action at page 7). The Office Action looks to Yi '730 to remedy this deficiency.

The statements in the Office Action regarding the teachings of Yi, however, are in error. Regarding the teaching of Yi, the Office Actions states at page 7, that "the first and third metals are the same (Cr in one example) and second and fourth metal layers are the same (Cu in one example). (See also col. 3, lines 7-14; col. 4, lines 32-49)." But these statements are not correct.

Yi at column 3, lines 7-14 states, in pertinent part, "second and fourth metal layers made of the same material as the first and third metal layers, respectively . . . ." This means the second metal layer is made of the same material as the first metal layer. This also means the fourth metal layer is made of the same material as the third metal layer. Because Yi teaches the first and second layers the same, and the third and fourth layers the same, withdrawal of the rejection is respectfully requested.

Column 4, lines 32-49 teaches a Cr layer 51, eight Cr layers 151 above the Cr layer 51, two Cu layers 155 above the eight Cr layers 151, seven Cr layers 151 above the two Cu layers 155, etc. Claim 17 requires, in pertinent part, "forming a refractory metal fourth layer above and on the refractory metal third layer". There is no teaching of Yi wherein the refractory metal third layer is above, and on, the refractory metal second layer, and the refractory metal fourth layer is above, and on, the refractory metal third layer, and regarding the similarities of the first and third and the second and fourth layers, the first and third layers are substantially the same metal, and the second and fourth layers are substantially the same metal.

If it is the intention of the Office Action to characterize the layers 51, 151 (first

occurrence at the bottom of FIG. 9), 53, and 55 as four metal layers, one must characterize the phased layers 53 as a Cu layer. But this only results in two Cr layers 51, 151, followed by two Cu layers 53, 55. This could be what Yi meant at column 3 as noted above, but it does not teach or suggest what is claimed in claim 17.

If it is the intention of the Office Action to characterize the several Cu layers 155 as a single layer, this fails to teach the element in claim 17, that the third layer is above and on the second layer, and the fourth layer is above and on the third layer, etc.

Because the cited references when combined, do not teach or suggest all the claim limitations, withdrawal of the rejection is respectfully requested.

Applicant notes that claims 19, 21, 23, and 25 depend from claim 17 and include other limitations. The combined teachings of Agarwala '584 with Yi, fail to teach all the limitations of these claims as set forth above. Because the cited references when combined, do not teach or suggest all the claims' limitations, withdrawal of these rejections is respectfully requested.

Claim 18 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Agarwala et al. (U.S. Patent No. 5,376,584) in view of Yi et al. (U.S. Patent No. 6,348,730 B1) as applied to claim 17 above, and further in view of Microelectronics Packaging Handbook, Semiconductor Packaging, Part II, 2<sup>nd</sup> edition, Tummala et al. eds., Kluwer Academic Publishers: Boston, 1997, pp. 132-139. Applicant respectfully traverses the rejection and requests the Office to consider the following.

The deficiencies of Agarwala '584 and Yi as set forth above are incorporated herein by reference. The Office Action cites to Tummala et al. eds., to teach "that it is notoriously well known (1) for the bonding pad to be copper (p. 137, last paragraph, and Fig. 8-6 on p. 138), as well as (2) for the bond pad to attach to one of the metallization layers (the third metallization layer as shown in Fig. 8-2, on p. 133). The Applicant agrees.

The Applicant digresses back to the objection to claim 18 and the figures, *supra*. The statement by the Office Action regarding the teaching of Tummala, et al. eds., confirms Applicant's assertion regarding the illustration of metallization within the box 12 of the instant

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application as conventional features disclosed in the description and claims.

Referring again to the rejection of claim 18, Applicant notes that Tummala et al. eds., does nothing to remedy the failure of Agarwala '584 and Yi to teach what is claimed in claim 17, from which claim 18 depends.

As set forth above, the Office Action admits that Agarwala '584 does not indicate that the metal layers include "first and third layers of substantially the same metal and the second and fourth metals of substantially the same metal." (Office Action at page 7). The Office Action looks to Yi '730 to remedy this deficiency.

As set forth above, the statements in the Office Action regarding the teachings of Yi are in error. Regarding the teaching of Yi, the Office Actions states that "the first and third metals are the same (Cr in one example) and second and fourth metal layers are the same (Cu in one example). (See also col. 3, lines 7-14; col. 4, lines 32-49.)" But these statements are not correct.

Column 3, lines 7-14 states, in pertinent part, "second and fourth metal layers made of the same material as the first and third metal layers, respectively . . . ." This means the second metal layer is made of the same material as the first metal layer, and the fourth metal layer is made of the same material as the third metal layer. Because Yi teaches the first and second layers the same, and the third and fourth layers the same, withdrawal of the rejection is respectfully requested.

As also discussed above, Column 4, lines 32-49 teaches a Cr layer 51, eight Cr layers 151 above the Cr layer 51, two Cu layers 155 above the eight Cr layers 151, seven Cr layers 151 above the two Cu layers 155, etc. Claim 17 requires, in pertinent part, "forming a refractory metal fourth layer above and on the refractory metal third layer". There is no teaching of Yi wherein the refractory metal third layer is above, and on, the refractory metal second layer, and the refractory metal fourth layer is above, and on, the refractory metal third layer, and regarding the similarities of the first and third and the second and fourth layers, the first and third layers are substantially the same metal, and the second and fourth layers are substantially the same metal.

Because the cited references when combined, do not teach or suggest all the claim

AMENDMENT AND RESPONSE UNDER 37 CFR § 1.111

Serial Number: 09/961,036

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Title: DUAL-STACK, BALL-LIMITING METALLURGY AND METHOD OF MAKING SAME

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limitations, withdrawal of the rejection is respectfully requested.

Conclusion

Applicant respectfully submits that the claims are in condition for allowance and notification to that effect is earnestly requested. The Examiner is invited to telephone Applicant's attorney John Greaves at 801/278-9171 or the below signed attorney to facilitate prosecution of this application.

If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

Respectfully submitted,

MADHAV DATTA ET AL.

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CERTIFICATE UNDER 37 CFR 1.8: The undersigned hereby certifies that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail, in an envelope addressed to: Commissioner of Patents, Washington, D.C. 20231, on this 3 day of February, 2003. (MONDAY)

ANN MCCRACKIN  
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Signature

**Clean Version of Pending Claims**

**DUAL-STACK, BALL-LIMITING METALLURGY AND METHOD OF MAKING SAME**

Applicant: Madhav Datta et al.  
Serial No.: 09/961,036

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Please replace the previously pending claim set with the claim set, as amended, below:

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17. (Twice Amended) A process comprising:

forming a metallization;

forming a refractory metal first layer over the metallization;

forming a refractory metal second layer over the refractory metal first layer;

forming a refractory metal third layer above and on the refractory metal second layer, wherein the refractory metal third layer is substantially the same metal as the refractory metal first layer;

forming a refractory metal fourth layer above and on the refractory metal third layer, wherein the refractory metal fourth layer is substantially the same metal as the refractory metal second layer; and

forming an electrically connective bump above the refractory metal fourth layer.

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18. The process according to claim 17, wherein forming a metallization comprises:  
forming a copper metallization pad over a substrate, wherein the copper metallization pad makes contact with a metallization selected from a range of metal-one (M1) to M6.

19. The process according to claim 17, wherein forming a refractory metal first layer over the metallization comprises:

depositing the refractory metal first layer by physical vapor deposition of a composition selected from Ni, Co, Pd, Pt, Ti, Zr, Hf, Cr, Mo, W, Sc, Y, La, and Ce.

21. The process according to claim 17, wherein forming a refractory metal second layer over the refractory metal first layer comprises:

depositing the refractory metal second layer by physical vapor deposition of a composition selected from Ni, Co, Pd, Pt, NiV, CoV, PdV, PtV, Ti, Zr, Hf, Cr, Mo, W, Sc, Y, La, and Ce in a solid-solution or stoichiometric ratio.

23. The process according to claim 17, wherein forming a refractory metal third layer over the metallization comprises: depositing the refractory metal third layer by physical vapor deposition.

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25. The process according to claim 17, wherein forming a refractory metal fourth layer over the refractory metal first layer comprises: depositing the refractory metal fourth layer by physical vapor deposition.